J-2X: Progress on the Ares Upper Stage Engine

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Abstract

NASA's Vision for Exploration requires a safe, reliable, affordable upper stage engine to power the Ares I Crew Launch Vehicle (CLV) and the Ares V Cargo Launch Vehicle (CaLV) (Fig. 1). The J-2X engine epitomizes NASA's philosophy of employing legacy knowledge, heritage hardware, and commonality to carry the next generation of explorers into low-Earth orbit and out into the solar system. As envisioned by the Exploration Systems Architecture Study (ESAS), the reference lunar mission would begin by launching the Ares V into orbit with the Earth Departure Stage (EDS) transporting the Lunar Surface Access Module (LSAM), followed by the Ares I, carrying the Orion Crew Exploration Vehicle, which would rendezvous with the EDS/LSAM before beginning its journey to the Moon.

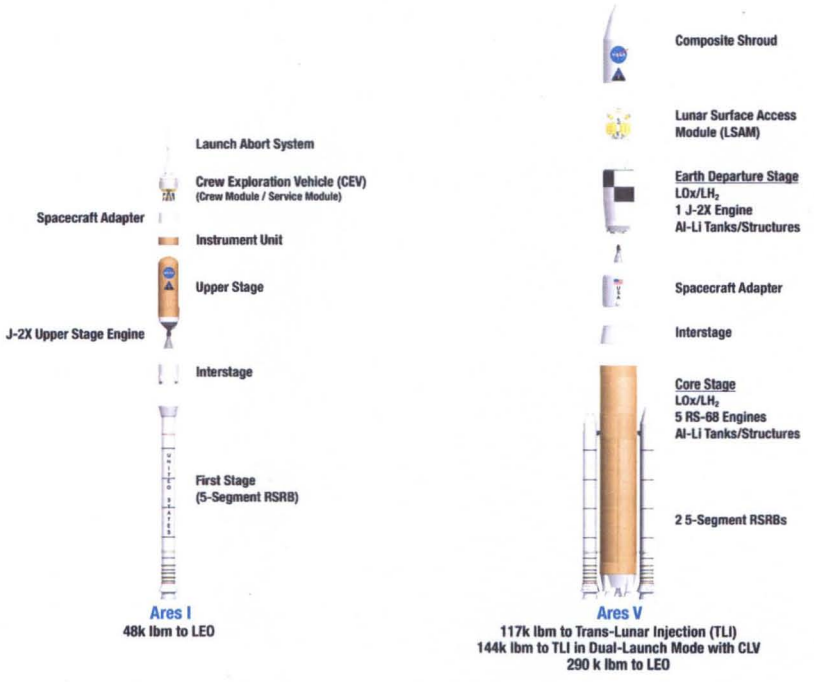

Fig. 1. Expanded views of Ares I and Ares V show common hardware.

To seek commonalities and streamline its hardware development approach to reduce programmatic, technical, and budget risks, NASA selected the J-2X as the upper stage propulsion for both the Ares I and the Ares V. This simplifies recurring and nonrecurring costs and reduces the number of new engines to be developed for the Ares fleet. It leverages a higher technology readiness level than that of the redesigned Space Shuttle Main Engine identified as a potential candidate during earlier architecture studies. The J-2X engine has an advantage in that the design is a human-rated engine capable of restarting in flight, something the SSME was not designed to do.

The liquid oxygen/liquid hydrogen (LOX/LH2) J-2X is a modernized variant of two historic predecessors: the powerful J-2 upper stage engine that powered the upper stages of the Apollo-era Saturn IB and Saturn V launch vehicles, and a the J-2S, a simplified J-2 variant developed in the early 1970s before the Apollo Program ended and briefly resurrected in the late 1990s for the X-33 Linear Aerospike engine program but never flight tested.

In January 2006, NASA gave the Exploration Launch Projects Office at Marshall Space Flight Center authority to proceed with J-2X development and in June 2006 NASA awarded Pratt & Whitney Rocketdyne, Inc., of Canoga Park, Calif., a letter contract worth $50 million to initiate design, development, test, and evaluation (DDT&E) of the J-2X engine for the Ares I and Ares V. In October and November of 2006, the J-2X element conducted a successful System Requirements Review and System Design Review. These reviews confirmed the engine can achieve the baseline requirements of 294,000 pounds thrust and 448 seconds minimum specific impulse needed for lunar missions. The J-2X conceptual design is shown in Fig. 2 below. The J-2X element is now proceeding with preliminary design phase leading to Preliminary Design Review in mid-2007.

Fig. 2. J-2X conceptual design.

In 2007, NASA and its industry partner, Pratt & Whitney Rocketdyne are proceeding toward award of a DDT&E contract to conclude with Design Certification Review in late 2012 and delivery of a development engine to support the Ares I first test flight. The critical path will be redesign of J-2 and J-2S turbomachinery to meet J-2X requirements and hot fire testing of the turbomachinery in a power pack assembly. The first powerpack test is scheduled for late 2007 at Stennis Space Center in the A1 test stand, which was handed over to J-2X from Space Shuttle Main Engine in late 2006. The engine system test program includes two sea- level test stands and one altitude test stand. In addition, a development engine will be hot fire tested with an Ares I upper stage Main Propulsion Test Article. This paper gives top-level details on accomplishments to date and discusses forward work necessary to bring the J-2X engine to the launch pad.

References

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